FUTURE SPACE EXPLORATION: AN EQUAL OPPORTUNITY EMPLOYER

Glenda G. Callanen

RAND Corporation
Santa Monica, California

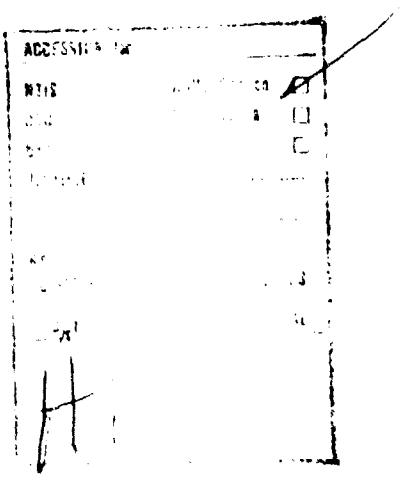
August 1975

FUTURE SPACE EXPLORATION: AN EQUAL OPPORTUNITY EMPLOYER?

GLENDA G. CALLANEN

August 1975

P-5492



The Rand Paper Series

Papers are issued by The Rand Corporation as a service to its professional staff. Their purpose is to facilitate the exchange of ideas among those who share the author's research interests; Papers are not reports prepared in fulfillment of Rand's contracts or grants. Views expressed in a Paper are the author's own, and are not necessarily shared by Rand or its research sponsors.

The Rand Corporation
Santa Monica, California 90406

TABLE OF CONTENTS

I. INTRODUCTION

The field of aerospace medicine plays a vital role in the selection, preparation and protection of astronauts. In order to insure the success of space missions and the present and future health of the astronauts, great care is taken to choose the best qualified persons for these vital roles. The election of potential candidates is made according to the state of health, the skills and personal qualifications, and the ability to withstand the stresses of space flight.

Only one female has to date participated in a space flight. In June, 1963, Valentina Tereshkova became the first woman in space by orbiting the earth 48 times as pilot of the Soviet Union's Vostok 6 spacecraft (8). The United States, however, has not thus far had a female astronaut. There are undoubtedly many nonscientific reasons for this: residual cultural traditions of protecting females from danger and physical hardships; protecting the American male ego by barring women from certain professions (notably the "hero" image producing fields); and preserving public confidence in and, hence, political strength of, American space programs by selecting astronauts who present an image of complete competence and durability.

As modern society becomes more technical, women are assuming increasingly important and sophisticated responsibilities. Today's political, social and educational institutions provide women with unprecedented opportunities to contribute to the explosive growth of technology, and it is not surprising that many are interested in participating in the conquest of space. Although the traditional psychological impediments are diminishing, they have produced some scientific reasons why the U.S. has had no female astronauts. Women's two major obstacles have been the lack of skills required for astronaut selection and a lack of data on the female's tolerances for space flight stresses. The latter problem has been partially reduced by the 1973 tests conducted by the U.S. Air Force at the Ames Research Center in California. Based on the test results of 12 Air Force nurses, which indicated that females apparently tolerate space flight stresses as well as males, NASA announced that women will not be excluded from the crews of the planned space shuttle flights.

II. DISCUSSION

Assuming they possess the same educational and intellectual qualifications, the female astronaut has certain physiological advantages over the male. Women are generally lighter in weight and require less oxygen and metabolic nourishment, important considerations when every pound of added capsule weight is a detriment to cost and capability factors of manned spacecraft. Examination has shown that women react more quickly to stimuli, tolerate boredom and monotony better, and are less prone to hallucinations during periods of sensory deprivation (5, p. 531). They are less susceptible to heart attacks and have a higher tolerance for radiation (9, p. 5). Under the theory that astronauts should be chosen for small mass and dependability, females would seem to be ideal subjects (7, p. 7).

Fatigue, Endurance and Response

The obvious anatomical differences between males and females would suggest different responses to stresses. Although very limited data are available, some attempts have been made to evaluate these responses. Due to the innumerable variables involved, it is difficult to draw definitive conclusions.

In one study a simple, repetitive task was performed after responding to a visual stimulus (6). A stimulus was presented, after which the subject was required to release a switch (reaction) and extend the hand through a photoelectric beam at a specific distance (movement). Various stages of fatigue and boredom were observed, until the subject reached the limit of isotonic endurance and could no longer continue to perform the task. From a comparison of the performances of men and women in this test, several conclusions seem justified. Men are faster in arm movement and can perform a simple task for a longer period of time. Women respond more quickly to a visual stimulus and seem to have a qualitative advantage in finer forearm muscle control. The subjective expressions of the subjects as to when their performance became slower were the same for both groups. This test of reaction time and speed of forearm movement, variables important in the piloting of space vehicles, did not show the superiority of either gender in performing the total task.

The Martin Company in Baltimore simulated space flight for over a year as a NASA project in the early 1960s. They found then that women were able to operate the controls for space rendezvous more quickly and efficiently than men, usually executing the maneuver on the first or second attempt (9, p. 13).

Between 1959 and 1961 Miss Jerrie Cobb, a noted pilot with an outstanding career in aviation, voluntarily underwent extensive testing by the Lovelace Foundation in New Mexico and the U.S. Navy at Pensacola. She passed all tests and was scheduled to receive an airborne electroencephalogram to record brain waves under the unusual stress of a high gravity load-stress aerobatic pattern. When Navy Pensacola wired Washington for permission for her to fly in a Navy aircraft for that test, reporting that they wished to ascertain the differences between men and women astronauts, the Pentagon sent a humorous reply: "If you don't know the difference already, we refuse to put money into the project." (9, p. 57). Permission was granted and she passed all remaining tests, but then was named a NASA consultant, which precluded her active participation in the astronaut proprogram (9, p. 57).

Reactions to Altitude Conditions

Sparse data exist on the symptoms of altitude sickness in females. In one study, a group of college girls resided for ten weeks at the summit of Pikes Peak, Colorado, at an altitude of 14,100 feet. They were observed at their normal low altitude residence before moving to the mountaintop, and were tested and questioned several times per day. Several medications were given to relieve high altitude symptoms, and were evaluated as to effectiveness. Significant illness occurred during the first four days at altitude, with the major complaints being headache, drowsiness, fatigue and insomnia. Only minor gastrointestinal and cardiorespiratory symptoms were reported. Blood pressures were lower and resting pulse and respiratory rate were higher. Electrical activity and X-ray appearance of the heart remained within normal limits. By contrast, males previously studied exhibited more frequent and severe gastrointestinal symptoms and sensations of palpitations at rest, shortness of breath, chest pain and chest tightness. Whereas men have reported changes in mood, in memory, and in ability to make decisions and perform complex mental tasks, women were generally more adaptable to these altitude symptoms. Of the medications used, none seemed particularly effective. It was concluded that further attempts of reducing high altitude symptoms were best directed toward prevention rather than suppression (4).

A study of altitude chamber flight reactions of both males and females over a five year period was made at the Biometrics Branch of the U.S. Air Force School

of Aerospace Medicine, Brooks Air Force Base, Texas. The multiple emotional and psychological parameters involved were not controlled. The method of testing was to perform standard flight profiles followed by rapid decompression, and to compare reactions to dysbarism. (Dysbarism describes the condition of body disturbances resulting from the existence of pressure differential between the total ambient barometric pressure and the total pressures of dissolved and free gases within the body tissues, fluids and cavities.) The males tested encountered the following symptoms (in descending order): ear block, abdominal gas pain, sinus pain, bends, hyperventilation, and toothache. Females experienced ear block, abdominal gas pains, sinus pain, hyperventilation, toothache and tingling. Only mild incidence of bends was found among females. Of the subjects who reacted unfavorably to decompression, 12.18 per cent of females had symptoms severe enough to necessitate removal from the chamber, as contrasted to 14.35 percent of males. However, about six per cent more females than males had to be removed because of severe abdominal gas discomfort (7).

Hormonal Functions

One area of great concern has been the effects of flight on the female hormonal functions. Again, no comprehensive data are available, although some information has been obtained in altitude studies and from female airline flight attendants.

In the previously mentioned Pikes Peak study, small reductions in the average duration of menstrual period and cycle length were noted at altitude. This condition persisted for about two months after returning to lower altitudes. It was not possible to determine whether this adaptation had been caused by altitude alone or by altitude and emotional stress factors combined. No noticeable changes occurred in the symptoms ordinarily associated with menstrual periods (backache, headache, cramps, etc.) (4).

Female metabolic rates are lower and more variable than in males, since metabolism usually rises before menstruation and falls afterwards.

> In chamber flights, female subjects have shown more abdominal distention during the luteal phase of the menstrual cycle. It is possible that these cyclic hormonal changes have strong influence on the susceptibility to dysbarism and could be the key factor in differences observed in chamber flight reactions (6, p. 6).

Data obtained from female flight attendants have indicated no permanent difficulties in the hormonal functions. In a study made from 1961 to 1967, about a quarter

of attendants noticed a worsening of menstrual functions during their first year. However, as flying experience increased, these same women reported improvement to or better than the pre-flying level. This indicates that psychic factors may be of greatest importance. No evidence was found that jet flight duty produces infertility or increased liability to miscarriage. Among ex-attendants, the number of pregnancies and births were in keeping with national norms (2).

In the absence of conclusive qualitative data, it should at least be noted that Tereshkova has married and borne apparently healthy children since her pioneer space flight.

Psychosocial Obstacles

It is assumed that modern technology is capable of solving the relatively minor problems of adapting space vehicles to the specific needs of women in the areas of personal hygiene and waste management. Changing mores in recent years have created a new social climate between working men and women, so that the psychosocial environment aboard future mixed-crew spacecraft should not be prohibitive. However, there are still some obstacles to the selection of females as astronauts.

It is generally held that some costs will be increased when women are admitted to the space program. Some modifications of hardware will be required of testing and training facilities, as well as the spacecraft itself. As we have seen, extensive amounts of clinical and experimental physiological data will have to be evaluated before women can be safely launched into space. Since the earlier NASA standard requiring potential astronauts to have jet pilot experience has been relaxed, women no longer face de facto exclusion based on jet ratings. (Although the Soviet Union utilized women as jet pilots, Tereshkova had had no previous pilot training.) Miss Cobb passed physical, laboratory, X-ray, physical competence, psychological, psychiatric, isolation, and Navy tests required for astronaut selection, but was not permitted to receive training or to demonstrate her abilities on a space-flight simulator. She noted some irony in this situation when she learned that 50 chimpanzees were being trained for space flight at Chimp College in New Mexico, among them a female! (9, p. 17) In the realm of formal education preparation, women have fared somewhat better than in the practical training. As early as 1962 there were 146 women in NASA alone who were classified as professional aerospace technologists (9, p. 61), and these numbers have increased throughout government and related industries in the past decade.

Some allege that an additional factor which could ultimately increase costs could be the expected attrition rate of female astronauts. After observation of the psychological factors among both male and female airline flight attendants, some parallels can be drawn. The stresses of fatigue, inadaptation, intolerance to time-zone changes, difficulties with sleep, somatic asthenia, emotional lability, oscillations of the thymic condition, and psychosomatic problems affecting digestion have been found among both male and female crew members. Under old airline policies, the average duration of a female attendant's career was about 18 months. Since the restrictions against age, weight, marital status and height were lifted, only a few years ago, the average service has increased dramatically to over 5 years (3, p. 30). The supportable inference is that women are serious about their professions when the industry demonstrates a serious desire to retain their skills and services.

III. CONCLUSIONS

It seems inevitable that women are to be essential participants in space flight. Even if they were only to take on the less scientific parts of the space mission, or if they wished only to help "colonize" distant planets, their basic skills must still prepare them to perform countless new tasks. The need for suitable training and evaluation of women in this role cannot be denied. Women will require increased opportunities for both formal education and practical training to prepare them for the rigors of space flight. Further, it will be necessary to obtain extensive physiological and psychological data on representative numbers of females to assess their potential for performance and endurance in space.

The available scientific evidence indicates that many women can eventually be fully qualified to join in the future explorations of outer space. They will be able to provide important resources in the fields of medicine, engineering, astronomy, physics, chemistry, geology, and other specialized areas. In the rapidly changing psychosocial environment, many women are already electing nontraditional, high-risk occupations. It seems likely that some women may seek the challenges of space flight. Without this eventuality, can anyone seriously expect that many men would still be willing to travel to Mars and beyond?

BIBLIOGRAPHY

1. Blanc, C. J., Digo, R., and Moroni, P. "Psychopathology of Airline Stewardesses", Aerospace Medicine, February 1969, pp. 184-187.

2. Cameron, R. Graeme, "Effect of Flying on the Menstrual Function of Air Hostesses", Aerospace Medicine, September 1969, pp. 1020-1023.

3. Ellingsworth, Rosalind K. "Flight Attendants Flexing Labor Muscle", Aviation Week and Space Technology, June 3, 1974, p. 30.

4. Harris, Charles W., M.D., Shields, J. L., Ph.D., and Kannon, John P., Ph.D., "Acute Altitude Sickness in Females", Aerospace Medicine, November 1966, pp. 1163-1167.

5. Ordway, Frederick I. III, Gardner, James Patrick, and Sharpe, Michael R., Jr., Basic Astronautics, Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1962.

6. Pierson, William R., Ph.D., and Lockhart, Aileene, Ph.D., "Fatigue, Work Decrement, and Endurance of Women in a Simple Repetitive Task", Aerospace Medicine, August 1964, pp. 724-725.

7. Ramos, Major Edwin D., USAF,MC, "Sex Differences in Chamber Flight Reactions", Unpublished research paper, United States Air Force School of Aerospace Medicine, Aerospace Medical Division, Brooks Air Force Base, Texas, 1968.

8. Seaborn, H. T., ed. TRW Space Log, Redondo Beach, California: TRW Systems Group, Winter 1969.

9. U.S. Congress, House, Committee on Science and Astronautics, Qualifications for Astronauts, Hearings before a special subcommittee on the selection of astronauts, House of Representatives, 87th Congress, 2nd session, 1962.